THE MODEL ENGINEER

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Smoke Rings

A "Lone Hand" in the Midlands

ANOTHER "silent reader" of the "M.E." has just come along and sent me a friendly letter of appreciation. His acquaintance with our journal dates back for some thirty years, with an interim period when for various reasons he was obliged to give up model making. He has, however, now returned to the hobby, and is equipped with tools and some materials. He is very anxious to get into touch with some locomotive enthusiast in his part of the country who would give him a little advice on one or two points of difficulty with which he is confronted. Will someone kindly respond direct? The address of my correspondent is Mr. A. Whitehouse, "Cross Inn," Cannon Street, Willenhall, Staffs.

Models and Full-size Machines

A CORRESPONDENT who is engaged in the preparation of a text-book on dynamics is desirous of obtaining some reliable data on the comparative performances of models and their prototypes. This is a subject of first importance to those who use models for research purposes in connection with scientific and engineering problems. Models are used for experimenting in the design of ships and aircraft, in the flow of rivers and tidal waters, in the design of structures to carry specific loads, and in the investigation of problems of all kinds arising in the design and functioning of engines and machinery. How far can the behaviour of the model be relied on as a reliable guide to the behaviour of the full-sized production? What allowances or assumptions must be made for the natural conditions under which the test of the model is made and those under which the full-sized structure will operate? How do considerations of temperature, expansion or contraction, steam or wind pressures, and the nature of the work to be done, apply to tests in miniature? What will be the comparative behaviour of materials of construction in the different scales? These are some of the questions which arise. No doubt some of our readers who have been engaged in research work have had to give thought to these matters, and have acquired useful experience. The subject would be of much interest to others in addition to my present correspondent, and I should be grateful for any knowledge which research workers may be able to contribute, or for any references to reliable data or experiences which have been published.

Model Engineering Weather

AN old reader, Mr. John H. Bryan, of Salt Lake City, U.S.A., when renewing his subscription to the "M.E.," sends me the following description of the winter weather he has recently experienced :—"We have had a terrific winter here. In the memory of people who have lived here all their lives (60 odd years), there has never been a winter like it. Fierce north-east winds raging across a mile of open space, blowing through the house at every conceivable and inconceivable crack, sub-zero temperatures of 10 below, snow day after day, and week after week, 7 weeks in this place with no running water (pipes frozen), except for a brief respite 3 weeks ago ; they are still frozen in spite of a decided moderation of temperature, being obliged to carry anything from 6 to 12 buckets of water from a relative's place 150 yards or so away in fierce, biting winds. The whole country-side a mass of ooze 2-in. deep, the hydraulic pressure from same causing several floods in the basement, soaking carpets, books, clothes-cupboards and beds, and necessitating myself and two elder children to crowd into the tiny front room. In spite of all this I did quite a bit of lathe work for friends (free of charge, of course)." It is good to know that despite this experience, Mr. Bryan's enthusiasm for his workshop remained unabated. Our own winter weather, about which we grumbled, seems almost like summer time in comparison.

Percival Marshall

*Small Capstan Lathe Tools

Notes on "tooling up" for repetition work, with special application to the small capstan attachment recently described in the "M.E."

By "NED"

THE methods which have been described for dealing with drilling and boring processes will cover nearly all general requirements in small capstan lathe work, as it is usual, in production practice, to design small components so that they can be machined by straightforward methods, and, if possible, at one set-up. Occasions sometimes arise, however, when special machining problems have to be tackled, and these are usually more difficult when they apply to internal work than external. Whereas, in the latter case, the tools can be applied, either alternatively or conjointly, in two directions—either endwise, from the capstan-head, or radially, from the cross slide—it is obvious that only endwise motion can be applied to the internal tools, unless some special and additional devices for feeding them are adopted.

Undercutting or "Chambering" Operations

An example of a special internal machining problem, which may be encountered by the small capstan lathe user, occurs when it is necessary to produce a blind hole which is "bigger on the inside than it is on the outside," like the traditional pair of ladies' shoes! This feature is occasionally specified on small tapped components, to produce an "undercut" or clearance space beyond the end of the thread, and is quite a sound measure from the point of view of mechanical ethics, though more often a pain in the neck to the tool setter. The process is usually termed "chambering" in machine shop vocabulary, and the problem which it presents is in inverse proportion to the size of the entering hole, and directly proportionate to the relative enlargement of the bore to be produced by the chambering tool, and the depth at which it is required to operate.

In large capstan and turret lathes, the problem may be dealt with by using an internal recessing tool mounted in a holder equipped with a short cross slide; or, in some cases, the lathe is provided with means of cross-traversing the turret-head itself. It is thus possible to bore and "chamber" the hole at one tool setting. But very few, if any, small capstan lathes are provided with any standard equipment for cross-traversing capstan-head tools, yet some means of effecting this end is obviously a necessity, to enable the operation in question to be carried out. The only thing possible, therefore, is to devise a special tool-holder for the purpose.

* *Continued from page* 352, "*M.E.,*" *April* 9, 1942.

Expanding Boring Tools

A method which will occur to many readers is to use a form of "expanding" boring tool, the cutter of which can be retracted within a holder sufficiently small to be inserted into the initial bore, and brought forward into the cutting position by suitable mechanism when required. There have been many such tools introduced at various times, and some of them have been fairly successful in practice. The writer had some experience with a particularly ingenious type of double-edged expanding tool, in which the cutters were normally retracted by springs, but were brought into action by a collar, adjustable on the outside of the bar, which abutted against the end face of the work when the required depth had been reached.

Mechanically Complicated

The disadvantage of tools of this nature, however, is that they are mechanically complicated and must be constructed to precision limits to work effectively. The entry of a minute chip or bit of swarf into the gear is disastrous, and it is by no means easy to make it proof against such an occurrence. There is obviously a very definite limit to the smallness of diameter of the tool bar. But an even more serious objection to them is that the cutters must be so small that their regrinding is difficult and their wearing life short; it is even necessary in many cases to make them integral with parts of the operating mechanism. For these reasons, therefore, a more robust form of tool, with the operating gear entirely outside the hole, and a simple form of cutter, will be found more generally useful and durable. A more or less normal form of internal recessing tool, mounted in a holder which is capable of cross movement, is the simplest solution; but a small cross slide is not easy to make or incorporate in a capstan socket tool-holder, and examples of two comparatively simple alternative devices are given herewith.

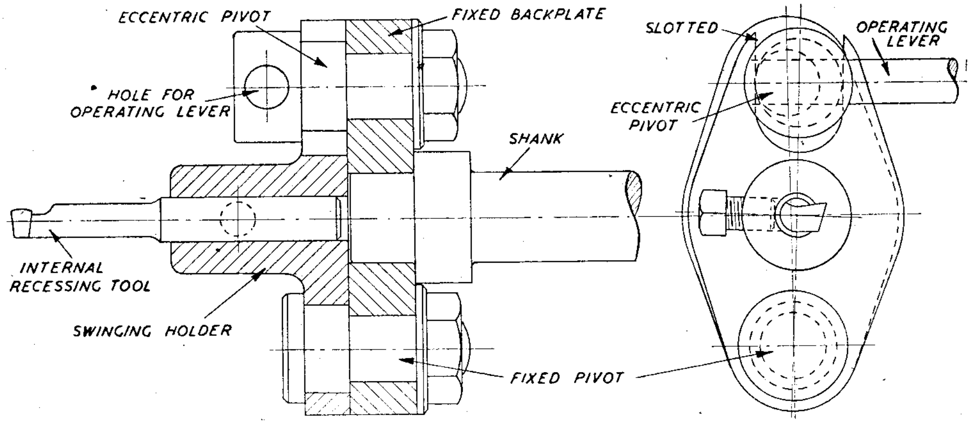


Fig. 17. A boring tool holder with side swing movement, for internal recessing or chambering operations.

A Swing Tool Holder for Chambering Tools

The device shown in Fig. 17 is an adaptation of the well-known "swing" recessing tool-holder which is very extensively used in automatic lathe practice; the only essential difference being that it is equipped with means of hand operation. It consists mainly of two plates or flanges, one of which is rigidly attached to the shank which fits the capstan socket (or, better still, bolted against the face of the capstan-head), while the other is fitted in contact with it, on a pivot which enables it to swing in a limited arc to either side of the central position. The swinging motion may be controlled in any convenient way; if desired, a lever may be attached to the swinging flange for direct action. The method of operation shown, however, is by means of a lever-actuated eccentric pivot engaging a slot in the flange, and this will be found to produce a sensitive and finely-controlled feed.

As with every device of this nature, the fitting must be good and working clearances fine in order to ensure successful working. It will be seen that the pivots are of robust proportions, and they must fit very closely both sideways and endwise; a slight "nip" to produce a certain degree of friction is all to the good. The backplate and swinging holder may be made of any convenient material, as their external shape is of no great importance, but the shape shown is selected, as it is often fairly easy to obtain cast-iron or steel pipe flanges which conform to it more or less closely.

No means of limiting the amount of swing, so as to produce a definite depth of undercut, have been provided on this tool, as it was found best to work to the full swing of the eccentric. It would, however, be a fairly simple matter to fit a limiting stop to it if desired. The lever employed for turning the eccentric was simply a 3 in. length of $\frac{1}{4}$ in. mild-steel carefully rounded off at one end and tapered slightly at the other, to drive into the hole in the eccentric collar. A more elaborately-shaped handle would have improved the appearance, and would undoubtedly have been justified on the grounds of good workmanship; but the purposes of utility were quite adequately served by the simpler fitting.

Eccentric Rotating Tool Holder

This is a somewhat simpler form of tool holder in which the actual cutting tool is rotated eccentrically to the bore of the hole to bring it into action. In some respects, this motion is inefficient, since it involves variable rake and clearance angles on the cutting tool, but it appears to work quite effectively in practice, and it has the further advantage that the degree of eccentricity, and thus the limit of feed, is readily adjustable.

As will be seen from Fig. 18, this holder is also built up from two flanges, but in this case they are rigidly bolted together, though with some latitude of relative position, provided by elongated bolt holes in the front flange. The latter incorporates a tubular extension which forms a bearing for an internal "quill," capable of partial rotation therein. This quill constitutes a holder for the cutting tool, which is held in its socket by a set-screw, and it has an enlarged collar at the rear end, which is primarily intended to prevent its endwise movement, and also to take a cross bar or lever which can be operated to provide partial rotation. A slot is provided in the flange through which the lever projects, and allows the latter to move through an arc of not less than 90 degrees.

The action of this tool holder is as follows:

Assuming that the device was adjusted so that the centre of the rotating holder was coincident with that of the work, the cutting edge of the tool would obviously have the same radial projection at any point of rotation, and no feed would be possible. But as it is mounted eccentrically to the work centre, the radial projection of the tool point will be greatest when it is in

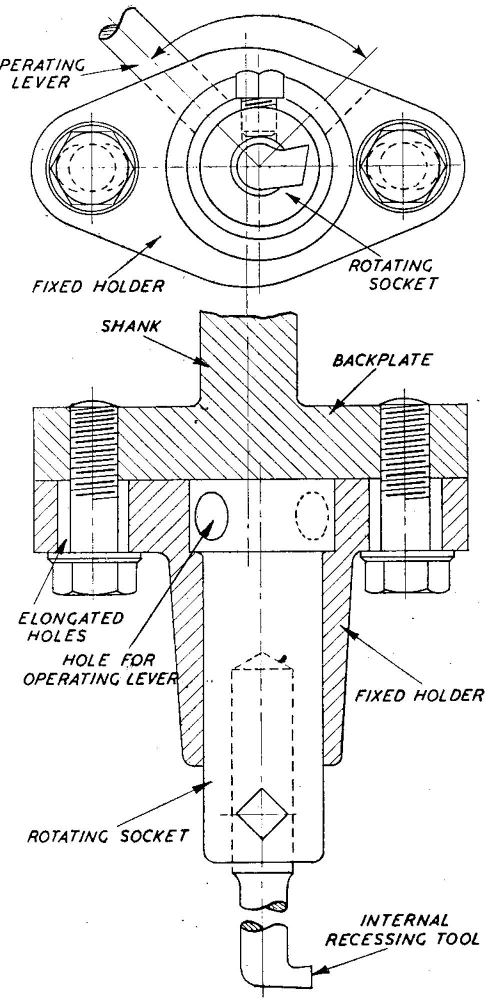


Fig. 18. An eccentric rotating holder for chambering tools.

line with the plane of eccentricity ; if it is turned out of line with this plane (i.e. the horizontal position) it will be retracted. In lathes rotating in the normal direction, the tool should be turned downwards to retract, so that it is brought into action *against* the cut ; if the reverse method is adopted, it is liable to snatch or dig in. The position of the cross hole in the quill, when the tool is retracted, is shown by dotted lines in the plan view. When chambering very small holes with a tool of this type, it is an advantage to bore the tool socket in the quill eccentrically, so that the shank of the tool is in line, more or less, with the centre of the hole when it enters.

End-Traversing Chambering Tools

In most cases, chambering tools are simply fed into the hole to a specified depth, and cross-traversed to produce an undercut to the width of the tool face. This is sufficient in most cases, where the object is to relieve the end of a thread, but it is sometimes necessary also to traverse the tool endwise by the capstan slide motion, to produce a longer undercut. As the capstan slide is only provided with end stops to limit motion in one direction, it then becomes necessary to provide some form of additional stop to work in the other direction, but capable of being put out of action to allow of the withdrawal of the tool from the hole. The exact design of such a stop must necessarily depend upon the type of capstan slide fitted, but in most cases the simplest and handiest device consists of a piece of rectangular bar, cut to the appropriate length or fitted with a jack-screw in the end, which can be introduced in the slide-ways between fixed and moving elements. In the case of THE MODEL ENGINEER capstan attachment, the stop bar can be inserted between the back of the slide and the rear frame cross bar.

Internal forming is in some cases carried out by means of a chambering tool with mechanically interconnected cross and end feed gear, but such work is hardly likely to come within the province of readers of these articles, and further description is therefore not warranted.

An Adjustable Boring-Head

Messrs. B. Elliott & Co. Ltd., Victoria Works, Victoria Road, Willesden, London, N.W.10, have furnished particulars of the "Crown" adjustable boring-heads, in which radial feed is provided for by means of a totally enclosed cross slide with micrometer screw adjustment. These tools are by no means specifically or exclusively intended for use on capstan and turret lathes, though their usefulness in this field is beyond question ; they are, however, equally adaptable to boring operations in vertical and horizontal milling machines, jig borers, and many other machine tools.

The boring-head comprises a mounting shank to which is attached the fixed element of the cross slide, and the traversing

(*Continued on page* 415)

FACE MILLING *with a* FLY-CUTTER

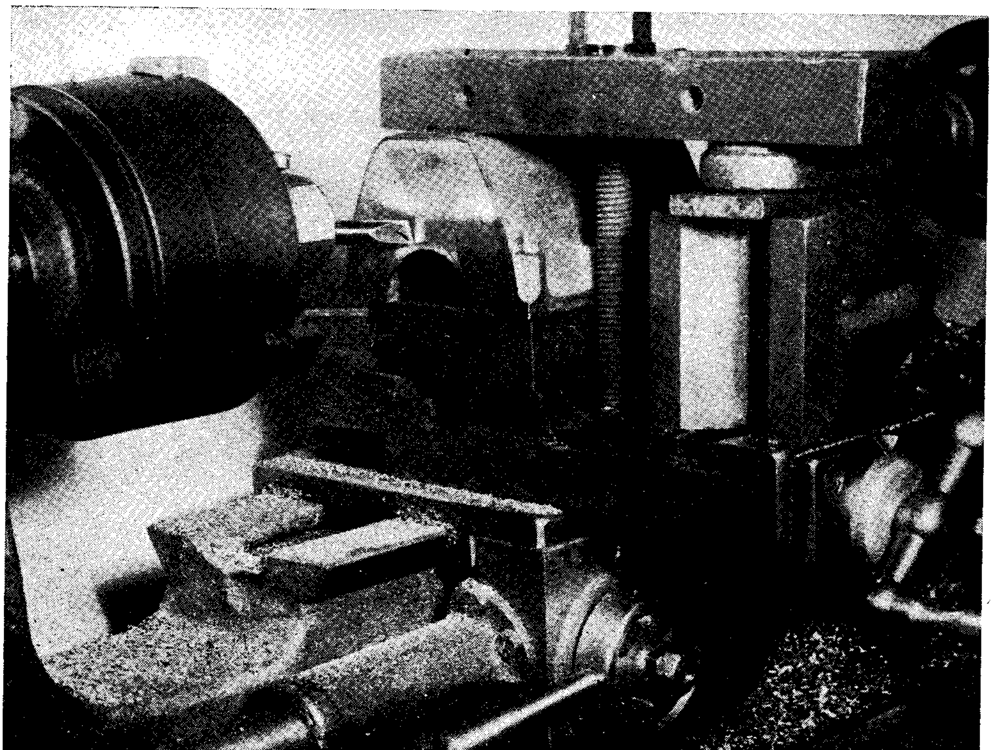
By E. T. WESTBURY

MANY model engineers fail to utilise to full advantage the possibilities of small lathes for performing simple milling operations, because of the expense of milling cutters and the difficulty of obtaining them. Perhaps it has not occurred to them that quite a wide range of milling operations can be carried out, reasonably efficiently, without the use of the usual type of milling cutter at all !

The method to be described and the type of tool illustrated are certainly not new—in fact, they are probably older than conventional milling cutters and processes—but they are by no means so widely known or applied in model engineering as they deserve to be. Not only are the required tools and appliances very easily made and adapted, but they have a much wider scope of application than any single type or size of milling cutter, and in certain circumstances are capable of turning out better work in the hands of the average small lathe user.

To many machinists the term " fly-cutter " signifies the last word in inefficiency, and conjures up visions of jury-rigged cutter spindles with the inherent rigidity of a bulrush, driven by " bootlace " belting from weird, fearfully and wonderfully conceived overhead gearing, and capable of taking only microscopic cuts on soft metals. To which it may be replied that there are fly-cutters *and* fly-cutters—to say nothing of various ways of applying them.

It is not proposed to deal here with the use of fly-cutters attached to a separately-driven milling spindle, except to remark that they are capable of much better results than many people seem to suppose, if only they are properly used and efficiently driven. But many lathe users have encountered real difficulties in the provision of a suitable means of driving them, and this subject is outside the scope of the present article. For the present, we are concerned only with a type of fly-cutter, or, more correctly, a single-point milling cutter,

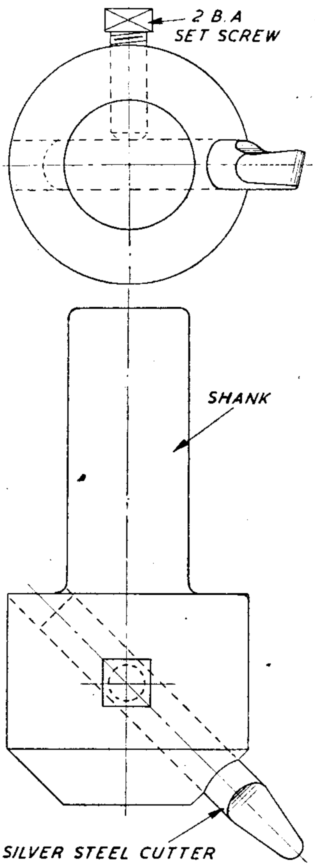


Milling the end face of sump casting for the engine of " 1831."

which can be attached directly to the lathe mandrel and used to operate on the vertical face of work bolted to the cross slide.

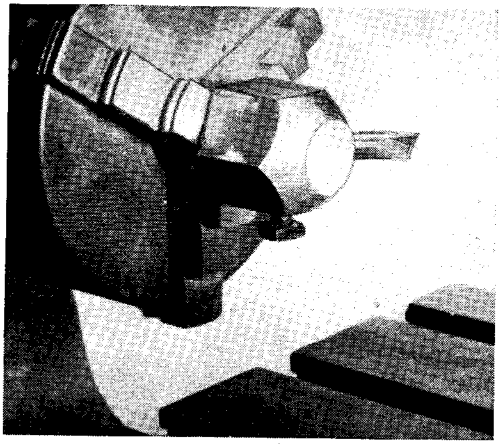
The form of tool holder and cutter shown in the drawing and photographs has been very successfully used in this way for a wide variety of work, some of which has been of a very exacting nature, and very definitely in the "tool room" class. It will be seen that the holder shown in the photographs differs from that in the drawing by having hexagonal tool-block, but the only reason for this is because the material most readily available at the time was a short length of hexagonal bar. As a matter of fact, the shape of this portion does not matter a great deal so long as the cutter can be held in it securely and with sufficient bearing surface to steady it against chattering and vibration.

The shank is turned down to a conveinient size to be held in the three-jaw chuck; this method of mounting is simple and handy for light work, but a more rigid method, which can be recommended for heavier work, is to make the holder in the form of an internally screwed adaptor which can be mounted directly on the mandrel nose. The overhang of the cutter is also considerably reduced in this way. It may, however, be noted that the simple holder shown has never given any cause for complaint on the score of rigidity, on any cuts within the capacity of the lathe.



Cutter holder for use in lathe chuck.

A cutter made from $\frac{1}{4}$ in. round silver-steel is mounted in the holder at an angle of 45 degrees to the axis, and secured by a set-screw. The precise angle is of no great importance, unless the occasion arises to use a form cutter for milling work to an exact profile. If desired, a square cutter bit may be fitted, and may offer some advantages, especially in respect of the range of tool steels which may be used, but it is not so easy to produce an accurate square hole as a round one; and it is further observed that the round cutter has proved quite adequate for all the work handled up to the present. It is advisable to provide two or more cutters of different lengths, to deal with varying widths of face, or with the cutting edges of various shapes. A flat filed on the top of the cutter, to form a bearing for the set-screw, will avoid bruising, and also locate the cutter in respect of proper rake and clearance angles. There is something to be said for making up more than one size of holder, as the principle is equally applicable to the machining of a face 6 in. wide or $\frac{1}{4}$ in. wide, if an appropriate size of holder and cutter is used.



The facing cutter mounted in self-centring chuck, ready for use.

It has been stated that this form of cutter is more suitable, in certain circumstances, than a conventional milling cutter for milling in the lathe. One of the reasons for this is that a small lathe is not primarily designed with a view to carrying out milling operations, and its rigidity is inadequate for using multi-tooth cutters to full advantage. It is seldom possible to take more than a mere scrape at one cut with an ordinary cutter, and if the metal is tough, or has a hard skin, the teeth will rapidly become dulled under these conditions. A single-point cutter may be fed in to penetrate under the skin, without imposing undue load on the lathe mandrel and slides.

Even with quite fair wear and tear, milling cutters inevitably need re-sharpening in course of time, and very few amateurs have proper facilities for carrying out this work. It is quite hopeless to attempt to regrind a cutter unless a form of grinder is available which is equipped with means of indexing the teeth of the cutter and grinding them all to exactly the same angle and radius. The single-point cutter, on the other hand, can be reground just as easily as an ordinary lathe tool, and in as little time. It is quite practicable, and indeed often advisable, to slip the cutter out and hone or grind it to a keen edge for the final cut, on work which requires to be accurate and well finished. Some idea of the finish possible may perhaps be gathered from the photograph, which shows a face milling operation in progress. The reflections on the surface indicate the degree of finish attained, which, it is ventured to suggest, is better than that usually produced by a conventional milling cutter used under the same conditions.

The ability to set the cutter out from the holder to any radius within its range is also a great practical advantage. Not only does it enable various face widths to be dealt with at maximum efficiency, but in many cases it avoids the necessity for precise accuracy in packing up the work to the required height. For instance, in the case of a face having a projecting rim either above or below it, the radius of the cutter can be set to clear the rim, or to take a side cut along its edge. It is quite possible to carry out slot milling operations with a cutter of this type if the holder is made small enough to pass into the slot without fouling the sides.

One of the great virtues of the less expensive types of model engineers' lathes is the facility with which the cross slide can be "cleared for action" and work bolted down to it for face milling. Assuming that the top of this slide is reasonably parallel with the lathe axis—and if errors in this respect should be found to exist, they are by no means impossible to rectify—any work bolted down and milled on the vertical face is bound to come out at a right-angle.

If a vertical slide is available the scope of the face milling cutter is still further extended; but even without the aid of this useful device its applications are innumerable. The writer has used it consistently for such purposes as surfacing slide-valve faces on steam engine cylinders, and the slide-valves themselves; the feet and slide bars of engine columns; crankcase flanges and bearers, edges of cylinder base flanges, and port faces, on model petrol engines; and operations too numerous to mention on accurate jigs and fixtures for use in engineering production.

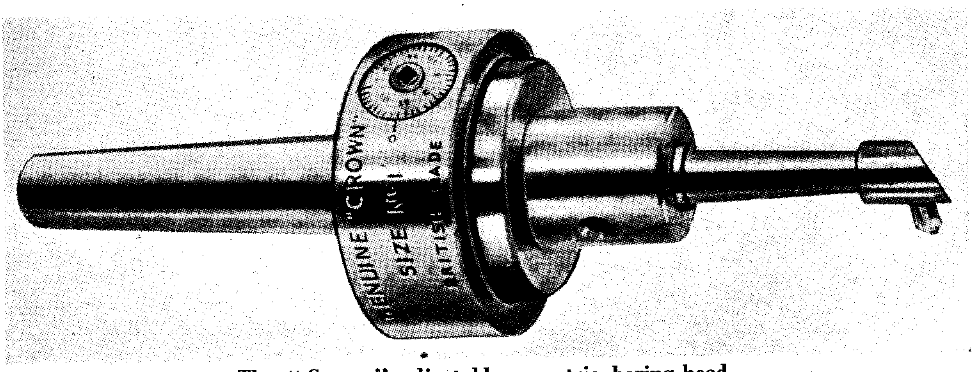
Small Capstan Lathe Tools

(*Continued from page* 412)

element is equipped with a socket to which the cutter bar is demountably fitted. It is possible to set the cutter bar dead concentric with the shank, or at any degree of eccentricity within the range of the tool, by means of a socket-head screw equipped with a micrometer index giving readings in 1/1,000 in. of radial motion. The slide can be locked when it has been set to the required eccentricity, but this is only needed when very heavy cuts have to be taken, as the head is fitted to close limits and has high inherent rigidity.

Two sizes of heads are available, one of which bores to a maximum diameter of $2\frac{1}{4}$ in., and the other 3 in. On the larger tool, it is possible to mount a special tool attachment for dealing with larger holes up to 10 in. diameter.

(*To be continued*)



The "Crown" adjustable eccentric boring-head.

* Making a 17-hole Division-Plate

By F. O. BROWNSON

THE problem set by Mr. Fooks is one which demonstrates the shortcomings of mathematics and makes one wish for the thousandth time that " π " might have been a more rational ratio.

However, the attainable accuracy of human effort leaves ample margin for the clumsiness of the mathematical too, so why worry?

Unfortunately, Mr. Fooks, in making his generous offer, does not stipulate the degree of accuracy required, and one is up against the question of workshop equipment available.

Given various sizes of micrometers, sine-bars, Johansson gauges, etc., etc., one might, with complimentary skill, produce a precision jig of amazing accuracy, yet few have access to such tools and fewer could use them to their best advantage, so I am going to risk possible derision by suggesting a method of construction based on the simplest of tools, to wit, the engineer's flexible rule.

Now, if an article is measured to a large scale and the scale thereafter reduced mechanically, the errors will also be reduced, thus, if we attach to our 5-in. diameter division-plate (or jig for same) a reasonably rigid lever some feet in length, visual measurements at its end will give micrometer accuracy near its fulcrum. It remains to decide convenient dimensions of such a lever, and methods of its construction with those of the jig which it controls.

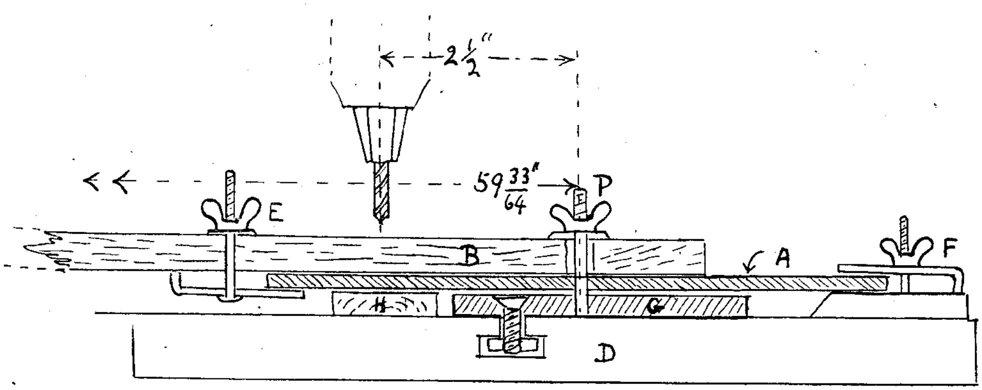
To approximate, let us take 22/7 instead of " π." We want a circumference divisible by 17 for convenience (because circumferential arc of 1/17 will be a whole number). The length of arc of 1/17 of a circle will be $\frac{22}{7 \times 17}$D., and multiplying by seventeen gives us an arc length of 22 in. and a diameter of 119 in.; halving the latter, viz.: $59\frac{1}{2}$ in., gives us the length of our lever such that a 22-in. movement of its tip covers 1/17 of a complete rotation.

If a steel plate is pivoted co-axially with the lever's fulcrum and provision made for marking or directly drilling this plate on a radius of $2\frac{1}{2}$ in., whilst it is all the time firmly fixed to, and rotatable with, the lever, we can, by drilling, then moving the lever tip 22 in. of arc and again drilling, produce a steel jig with holes 1/17 of a revolution apart on any desired diameter.

Now as to accuracy and some means to balance out errors. We have taken 22/7, but it is too large, really, equalling 3.14285 instead of $\pi = 3.14159$, so instead of 22 in. arc length what we really want is 7 π, or neglecting the fifth decimal, 21.9905 in., an error, in excess, of 0.0095 in. or $9\frac{1}{2}$ thou. This might be barely discernible visually, except that we must work with a lens and needle-point to an engraved line on our rule. This is where the lever comes in, however, for $59\frac{1}{2} : 2\frac{1}{2} = 24 : 1$ nearly, and the $9\frac{1}{2}$ thou. error is reduced to under $\frac{1}{2}$ a thou. at the jig, but it is still serious, since in jig-drilling, by means of plugging the last hole whilst drilling the next and so on, our error accumulates and the seventeenth hole will be 6 thou. out, at least.

We must evidently chuck 22/7 overboard and use π, but how on earth can we visually

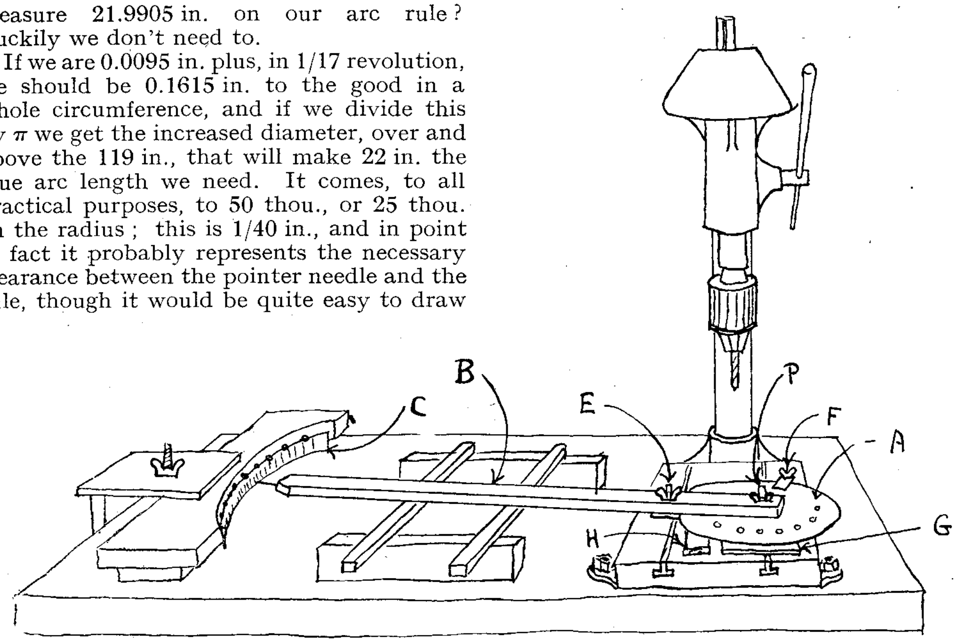
* *An entry in our recent Division-plate competition*



Details and method of fixing pivot plate by csk. screws. (Not to scale or true section line.)

measure 21.9905 in. on our arc rule? Luckily we don't need to.

If we are 0.0095 in. plus, in 1/17 revolution, we should be 0.1615 in. to the good in a whole circumference, and if we divide this by π we get the increased diameter, over and above the 119 in., that will make 22 in. the true arc length we need. It comes, to all practical purposes, to 50 thou., or 25 thou. on the radius; this is 1/40 in., and in point of fact it probably represents the necessary clearance between the pointer needle and the rule, though it would be quite easy to draw



General arrangement, laterally condensed: A, division-plate or jig; B, lever; C, rule; D, drill table; E, lever clamp; F, fixed clamp; G, pivot plate; H, drill packing; P, pivot or lever fulcrum.

the needle out another 64th, making its projection 33/64ths. instead of ½ in. from the wooden lever, as later explained.

So we have disposed of a cumulative positive error and may conclude that such faults as may exist will be "plus or minus" errors due to the human element.

I might mention here that, supposing there was a maximum error on our 5-in. division plate of, say, 5 thous. and one used it to gear-cut a 1-in. pinion, then the error on the pinion would be only one thousandth, from this cause.

However, in drilling a jig we could drill, not two, but several holes by means of a clamp attachment between the wood lever and jig steel. The jig being clamped to drill table whilst the lever was released and returned back along the scale to its starting point, then again clamped to the jig and the latter released from drill table for the next movement.

Of such a series of holes, one pair would show least error, and they could be tested by means of fitting silver-steel plugs of exact diameter to peg in the holes and then miking across their protruding shafts.

Trigonometry gives us a lift here, and what we want to measure is the chord length of 1/17 arc, or the base of the isosceles triangle formed by joining the circumferential ends of the radii of this arc.

We first bisect the apex angle and we get 10 deg. 35′ 17″ about (i.e. $\frac{1}{2} \times 1/17 \times 360$), the sine of which is 0.1837 and our chord length is given by 2(R sin 10 deg. 31′ 17″) = 2(2.5 × 0.1837) = 0.9181 in.

This is the required distance centre to centre of our plugs and we must add twice the radius of them to get the mike reading we hope to obtain. If they are ⅛ in. we add 0.125 to 0.9181 = 1.0431 in. so a 0-2 in. micrometer is needed.

Now, it may be said, why bother with the lever gadget, why not rotate the jig direct by means of the mike? Well, for one thing 0-2 in. mikes are not very common, and for another there is more chance of error, when measuring chords. The radius must be exactly 2½ in., or known to fine limits, and the miking must be done precisely along the chord axis—neither easy to achieve. Furthermore, I fear it would fall under Mr. Fook's "copying" embargo, for one would be using the mike screw as a worm-driven dividing-head!

In the lever method, the radius of the division holes is immaterial, which is no mean advantage, and various divisioning can be done on diverse radii on one jig with very simple calculation.

Now for the "set up"—a lever of seasoned hardwood, say 2 in. × 1 in., is drilled and bushed with brass near one end. It is then cut exactly 59 in. long from the bush, or fulcrum centre, and a stout darning-needle set eye-in at the free end, so that it projects 33/64 in. from the wood as aforesaid. The

bushed end is provided with a perfectly-fitting pivot pin, say, $\frac{3}{8}$ in. diameter, which in its turn is screwed or brazed vertically into a 3/16-in. steel plate of suitable size for clamping to drill table. This pivot is made long enough to accommodate $\frac{1}{8}$-in. or 3/16-in. jig steel or division-plate blank bored to fit pivot and situated beneath the lever to which it can be clamped or bolted as required.

The pivot is fixed to drill table at the required radius from drill centre on the side away from lever pointer and the work-piece and lever put in place with suitable drill packing as required. The lever must have room to swing over the desired arc without itself fouling the drill and should be behind the drill centre, always.

A piece of board is now marked on one edge to 59 33/64 in. radius for some 25 in. of arc. This is cut out on fretsaw and a 24-in. steel rule of good quality is fixed by means of screws and washers clamping its top edge to this curve (top edge so as to leave bottom engraving unobstructed).

The board and rule are then clamped to bench or otherwise in such a position that the lever pointer just clears the rule throughout its traverse.

If thought well, the lever may be supported by and slide upon two or more wood battens or metal bars fixed horizontally to bench in order to obviate any sag of the lever. In any case one such support must be provided near the pointer end. The lever moves in a horizontal plane, of course, and the pivot must be free of any strain.

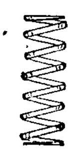
Operation—pointer is set to the 1-in. graving, say. Jig or plate is clamped to lever and also to drill table. A small, accurately-ground drill is run through jig. Table clamp is released, pointer moved to 23 in. graving, table clamp tightened and jig again drilled. Lever clamp is then slacked, lever returned to 1 in., lever clamp tightened, table clamp slacked, pointer moved to 23 in., table clamp tightened, jig again drilled and so on, as many holes as required.

It will, I hope be clear that I use the term "jig" for brevity, it being a matter of choice whether the division-plate is drilled direct or whether a jig is made from which optimum hole spaces may be chosen for subsequent jig-drilling of the division-plate, as mentioned above.

In conclusion, Mr. Fooks' generous two-guinea "carrot" has so stimulated the grey matter, as did the actual vegetable my childhood's donkey, that I have devised a perfectly good method of circular divisioning suitable for any straight gear-cutting job on the lathe without using a division-plate of any kind. Furthermore, there is no limit to the number of teeth that can be formed.

How to Make Small Helical Springs

SMALL helical (spiral) springs used in model locomotive construction for safety-valves, axle-boxes, buffers, etc., and for many other purposes in model making, need to be correctly made if they are to function properly. If they are to be used in compression, as they mostly are, it is a mistake to close-wind them on a metal rod and afterwards stretch or pull them out to the required length. Using that procedure, you may, by luck, produce a spring with equally-spaced coils and axially straight, but the odds are against it. A much better plan is to use a former to space the coils evenly when winding. Choose a suitable wood screw, cut off the head, and use it as a former, by gripping it in the vice or s.c. chuck and winding the wire tightly in the thread of the screw. The coils will spring back a little on being released, and a few trials with different sized screws will show the right size of screw to use to produce a spring of a definite diameter. As the working range of such springs is in most cases very small, there is no need to harden and temper them if made of hard "piano" wire, but it is important that the ends should be ground off in a plane perpendicular to the axis. Push in a match-stick (for very small springs), skewer or any bit of wood that will fit tightly inside the spring and dab the spring squarely against the side of a revolving grinding wheel. The end coil of the spring will immediately become red-hot and will be pressed down nearer to the coil below and at the same time be ground off to a tapering point. The operation is so quick that the heat has no time to travel down the spring and spoil its temper. Reverse on the stick and do the other end in the same way. Test the spring by standing it on its end on a smooth level surface. If right, it should stand upright like a ninepin. If it tumbles over or looks like the leaning tower of Pisa, the grinding has not been correctly done, and must be repeated until right. If the spring is too long, cut a bit off and regrind. If too short, it may be stretched slightly, although it is better to make another one a little longer and try again.



Springs of hard brass or p.b. wire can be made in the same way, for use in positions where steel would rust.

The sketch shows how the spring should look if correctly made and ground.—G. E. COUPLAND.

"BATTIWALLAH" on

AMATEUR TOOLMAKING

THE recently imposed embrago on cutting-tools means that, when the present depleted stocks held by small retailers are exhausted, the amateur engineer will be unable to obtain replacements or other requirements in drills, taps, dies, reamers, etc., unless he is utilising his workshop in the production of articles for the war effort, in which case he should be able to obtain supplies under permit.

Hence, the amateur who seeks his recreation in making model locomotives, marine engines, petrol engines and so forth may find his activities curtailed as his present stock of cutting-tools becomes worn out or broken. As the engineer is a man of resource, however, he should be able to meet his needs by home production.

The average amateur's lathe, if B.G. & S.C., meets most needs for producing taps, dies, reamers and drills. A hand shaper or a sturdy milling attachment to the lathe are valuable adjuncts, likewise a grinding-head for the lathe, invaluable for finishing flutes in taps and reamers. If you do not possess the latter, it is a fairly simple matter to make one from a ½-in. or ⅝-in. shackle holt, boring out the pin hole and bushing it to take the spindle. This accessory can be secured by the lathe tool-post or on the faceplate, by simply clamping at the U. Failing the shackle holt, no doubt the local blacksmith would spare a few moments to knock a similar shape up from ½-in. or ⅝-in. square M.S.

Worn-out files, old cold chisels and crow-bars are a source of tool material, should normal sources of supply fail.

Taps

Cut the length of stock, which should be larger in diameter than the tap size, and centre. Reduce to exact diameter along length to be threaded: for ¼ in or so at tailstock end, reduce to diameter of thread root. For sizes above 3/16 in diameter, reduce remainder of length to a fraction below root diameter. Below this size, reduce remainder to the same diameter as over the thread, for tap sizes down to ⅛ in. diameter.

It is preferable to check the essential diameters with a micrometer throughout the length, as most amateur's lathes tend towards slight taper. If your tailstock is adjustable, correction can be made; but do this before you get down to finished diameter. Allow 1 mil. when tooling for a touch of fine file and polishing, before threading.

The correct tool form for threading is essential. (Refer to "Screw Cutting Simply Explained," Percival Marshall.) A H.S. tool is much to be preferred, as it will retain its form very much longer and gives a cleaner finish than a carbon steel tool. It must be set at true centre-height. Now set the top slide so that its feed screw makes an angle with the faceplate surface of half the thread angle, 27½ deg. for Whitworth thread and 23½ deg. for B.A., by means of a sheet tin template cut at the appropriate angle. This procedure when feed is on the top slide causes the whole left side of the threading tool to cut and relieves the point from all thrust, so giving a smooth finish. The tool will loose its point form, even if H.S., if the feed when cutting the thread is normal to the lathe-centre's axis. The reduced part at the tailstock is the depth gauge, and cutting should proceed until this part is just marked by the tool.

Fluting is best done by the hand shaper if you possess one. If so, before removing the work from the lathe, scratch three or four lines along the thread, according to the desired number of flutes, by means of a pointed tool mounted sideways in the tool-post—not the threading tool—using a change-wheel as a divider. Clamp the job to a piece of M.S. in which a V has been cut, on the shaper table. Using a round-nose tool, cut the flutes, siting the scribed lines centrally with respect to the tool-point. Note the finishing position of the vertical tool feed on completing the first flute, so that the others can be cut to the same depth. A piece of soft 22 gauge copper sheet between the work and the V groove prevents damage to the thread crests. The shaper leaves ragged adherent chips at the ends of the flutes: these can be removed with a small cow-mouthed chisel or a broken-ended round file of diameter suited to the flutes, which latter will give quite a workable finish in the absence of grinding.

In the absence of a shaping machine, the flutes can be cut with a round-nose tool mounted in the lathe tool-post sideways, and feeding the cut with the lead screw or by a milling attachment or a milling machine, or as a last resource, by filing. This latter process is, however, very tedious, and requires extreme care.

With a fine-cut file now back off the

threads to the roots at the non-cutting sides of the flutes and make sure you select the correct edges, or the tap will not cut: if a taper tap is intended, also file down the thread, commencing about halfway along the threaded length and increasing the amount removed up to root depth at the tap point cutting edge, giving a little extra backing away from the cutting edges. It is helpful to examine carefully the backing of a "bought" tap as a pattern for the backing operation. Finish off filed surfaces with fine oil carborundum slip.

Now harden and temper. See later notes respecting this operation.

Grinding the flutes gives the taps quite a professional appearance as well as removing the slight burrs left on the thread after machining and filing the flutes.

The writer's procedure is to attach the grinding-head to the lathe faceplate, using a spring curtain line for a drive, as this allows a considerable latitude in adjustment. On the face of the vertical slide a piece of 1 in. square × 3 in. M.S., through which a No. 1 Morse taper is bored, is bolted so as to mount at right-angles to the lathe axis, a tailstock drill chuck. This is readily adjusted so that it holds and by means of the slide rest traverse, feeds the tap parallel to the plane of, and across, the lathe bed. The grinding-head is secured at the correct height either by temporarily tightening down the mandrel bearings, or locking the mandrel by means of the back gear.

A 3-in. diameter, ¼-in. wide abrasive wheel with rounded edge run at approximately 2,500 r.p.m. finishes the flutes perfectly in 2 or 3 fine cuts. Be careful to feed very gently on the vertical slide and the slide rest traverse to avoid taking the temper out of the work.

Time is saved by making taps in pairs—plug and taper, or better still in threes, that is including a "second" tap.

Dies

Turn up the blank from an old file, chisel or crowbar, or if you are lucky enough to possess it, from a piece of round cast-steel bar. 13/16 in. diameter is the normal finishing size for dies up to ¼ in. Whitworth or 5/16 in. 32 or 40 t.p.i. above these sizes 1-in. dies are recommended. Mount blank in S.C. chuck and drill hole centrally of correct tapping size with drill mounted in tailstock chuck. With a similarly mounted taper reamer, open out the tapping hole to the thread overall diameter. This taper should leave not less than one-third of the length of the tapping hole at its original diameter. Either with the home-made taper tap or a keen "bought" one mounted in tailstock chuck, thread the blank and use cutting oil. Pull the work round by hand; do not drive the lathe for cutting the thread.

Whilst still mounted in the lathe, scribe a circle on the blank with a scriber mounted in the tool-post, of diameter suited for centres of the holes forming the cutting edges. For good results this should and can be done to a nicety. The cutting edges should be normal to the thread circumference so that the holes, when drilled, should intersect the tapped thread crests at 90 deg. The correct radius of the scribed circle is the square root of the sum of the squares of the radii of the thread (overall) and the cutting holes. The scriber setting can be measured from the tailstock centre. Using the S.C. chuck jaws as reference points against a chalk mark on the headstock bearing, mark three diametrical lines with the scriber on the work and where these lines intersect the scribed circle you have the equidistant centres at correct radii for the cutting holds.

If you are making dies from taps you have also made, thread a small piece of M.S. whilst the lathe is still set up, or, otherwise, a piece of already threaded material, if available.

Now insert this into the die and, commencing at the fully threaded side, drill the three cutting holes, and before removing this "core," trim up the cutting edges with a fine warding file, so as to leave them normal to the thread circumference. The "core" keeps the cutting hole drill on centre and prevents burr when trimming the cutting edges. Now remove core. Finally, make a saw cut from the periphery of the die to one of the cutting holes, to provide for die adjustment. The die is now ready for heat treatment.

Reamers

Down to about 3/16 in. diameter, straight-fluted reamers can be made, using either round silver-steel stock or stock reduced to the required accurate diameter in the lathe, observing the same precautions against taper as referred to for taps. Turn down the shank of the blank as for taps, but after fluting, and slightly taper off the point of the blank before fluting; 5 mils. at the point is sufficient. Cut the flutes as described for taps, except that grinding them follows machining.

With a file, back off all but about 1/16 in. of each of the remaining "lands" at an angle of about 70 deg. with the radius through the cutting edges; this can be judged with care—precision is not essential.

Now, with a fine-cut file, remove the remainder of the original circumference at right-angles to the radii through the cutting

(*Continued on page* 422)

* Mr. J. W. Pattison

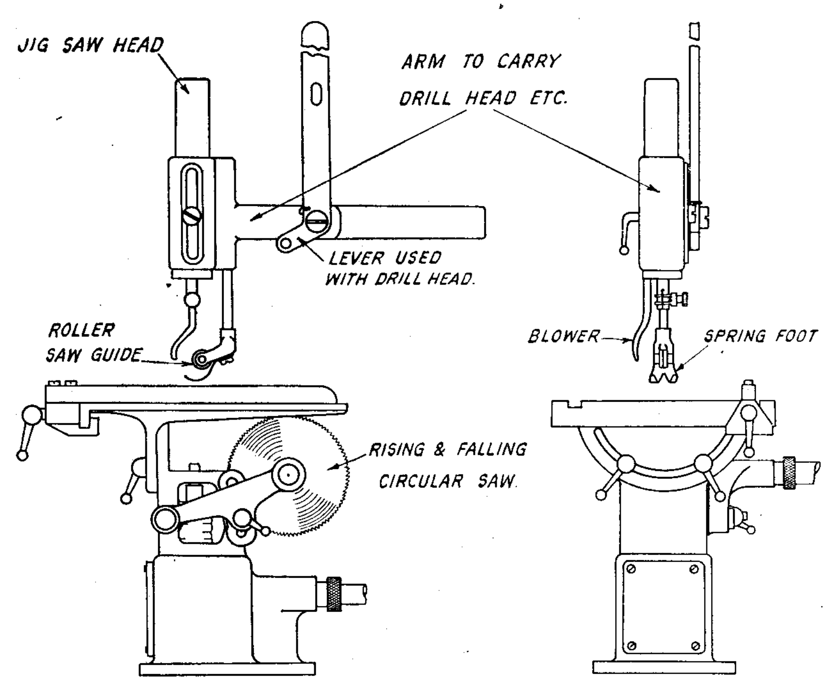
Designs a Lathe —

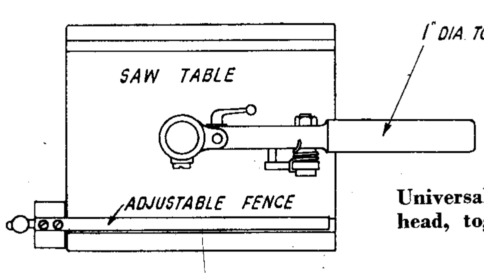
and some Gadgets for it

THE lower half of the jig-saw is a casting, enclosing a disc crank which imparts a $1\frac{1}{4}$-in. stroke to the saw. Supported by it is a table which may be tilted and clamped at any convenient angle. The unit is secured to the lathe bed by a single bolt passing through a hole drilled therein. The upper half is brought into register with it by some definite marking on the auxiliary bed. In this way, the set-up should only be the work of a moment.

* *Continued from page* 396, "*M.E.*," *April* 23, 1942.

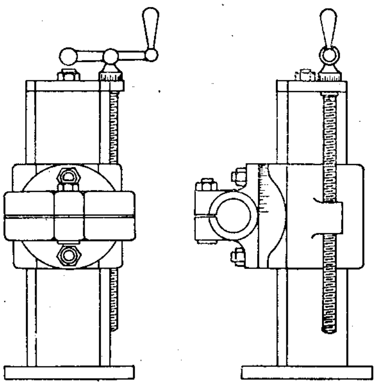
For sawing out intricate shapes in sheet metal the jig-saw is ideal, and any material may be sawn, if a suitable blade or knife is employed. Wood, bakelite, fibre, etc., may be sawn, and such material as cloth, cut with a knife blade. By using the lower half of the machine alone with a sabre saw in its chuck, intricate shapes may be cut in thicker materials and should be useful in pattern making.

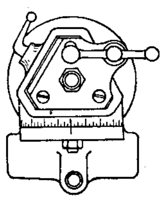




Universal arm shown carrying jig-saw head, together with circular saw and jig filing machine.

By removing the saw clamp, the remaining exposed socket becomes available for small machine files. With the mechanism set to the bottom of its stroke, there is plenty of room to swing the circular saw into position. Either metal or woodcutting saws may be used and the swing movement of the saw arm is the equivalent of a rising and falling table ; and added to this, there is the tilting movement of the table itself. An adjustable fence is clamped to the front edge of the table, and two slots are included for use with an angle-gauge. With a gap-piece removed from the centre of the table, it would appear possible to attempt even surface grinding, although its scope would obviously be limited.





Universal drilling and milling machine bored to carry any of the rotatable tools. Similarly, a small faceplate or slotted table or anything fitted with a 1 in. dia. holding - piece could be mounted.

The other gadget is a universal milling slide and needs little description, except to mention that the gib-piece is adjusted by four screws and may be locked by a handled clamping-screw. It will, of course, carry any of the rotatable tools, being bored out 1 in. diameter for that purpose. Besides the uses to which the above gadgets can be put, it would appear possible to do a little planing on anything mounted on the boring table, either by moving the work mounted thereon against a tool held in the auxiliary saddle, or by swinging the auxiliary bed radially. This latter experiment suggests, also, that with a suitable clapper-box the tailstock might be used as a shaper for anything within its capacity, the large dimensions of the ram suggesting that it would be amply strong enough to perform this task.

There are numerous other uses to which the machine and its gadgets could be put, as indeed there are many more gadgets which could be added, until the machine became a veritable concentrated machine-shop ; but as these appear to be never-ending, imagination must be left to the reader to think them out for himself.

Amateur Toolmaking

(*Continued from page* 420)

edges just down to the cutting edges, no more and no less. Painting the " lands " with " plumbers' black " or red lead facilitates the accuracy of this filing operation. After heat treatment, touch up the cutting edge flats and the flutes with carborundum oil slips, and again you have quite a professional-looking job.

Twist Drills

Again flute a piece of silver-steel or reduced stock of desired diameter with two flutes, as already described for taps and reamers and finish by grinding, but flute a longer length than that required for finishing. Gripping the shank of the work tightly in the chuck of the lathe and the other end in the tailstock chuck, form the twist, working back the tailstock to keep the work straight. Remove the damaged fluted part and, after straightening and grinding the point, the drill is ready for hardening and tempering. Sizes between about $\frac{1}{8}$ in. and 5/16 in. can be successfully made, but the absence of lands makes these home-made drills unsuitable for very deep drilling, as they tend to bind.

Heat Treatment

A muffle furnace is a very useful adjunct for the amateur toolmaker. Procure half a dozen firebricks approximately 4 in. $\times$ 6 in. $\times$ 1 in. and secure four together with clamping straps to form a chamber approximately 4 in. wide, 2 in. deep and 6 in. long and secure another of the bricks to close one end of the chamber. With an old hacksaw, cut strips from the remaining brick to lay across the bottom of the chamber to support articles being treated.

Mount the whole on a suitable stand applicable to your gas burner or blowlamp, as the case may be. With a half-pint size of the latter, taps, dies, reamers, etc., up to $\frac{1}{2}$ in. can be satisfactorily hardened and tempered, and, of course, the muffle is suitable for many other heat treatment jobs. The residual heat at the back of the muffle provides all that is required for tempering small tools at a temperature uniform throughout in their mass.

SCREWS SCREWS SCREWS SCREWS

By "L.B.S.C."

Don't let the shortage worry you. Make them yourself.

THE fact that small screws are scarce doesn't half worry some good folk! A builder of the evergreen and ever-popular "Maisie" wrote me the other day and wanted to know why on earth I specified sixteen 3/32 in. hexagon-headed screws in each cylinder cover. Said he had just machined up his cylinders, tried to get the necessary screws to assemble them, and found he had about as much chance as if he were seeking a slice off the moon. Drew a blank practically everywhere, but one "model" shop offered to supply a dozen, at the prewar price of a gross. What was he going to do about it? Did I know of any source of supplies, or could I suggest any way out of the difficulty. He didn't want to stop work on the engine, because—as is the case with almost all the locomotive builders at the present time, including your humble servant—it was just the necessary "break" that prevented war worry driving him into the loonies' home. As there are probably many others in the same boat, maybe a little dissertation on the subject will be acceptable, so here goes.

Hundreds of 'Em!

The sixteen-screw covers were fitted to the original "Maisie," No. 1 of that large family, to please our old friend "Bill Massive," who simply adores hundreds of little nuts and bolts and rivet-heads all over a little locomotive. Incidentally, if he had knocked bits of skin off his knuckles and other parts of his anatomy, torn his overall "slop" and performed sundry other acts of "involuntary sabotage" against their big sister's counterparts, he wouldn't be *quite* so keen! However, I must freely admit that they certainly do add to the appearance of a little engine whose big sisters bear similar adornments, as do "Maisie's." That replies to our friend's first question; but, as I mentioned in the instructions, he is quite at liberty to use a smaller number of larger screws. Eight of 6 B.A. or six of 1/8 in. or 5 B.A. would do. To preserve the realistic appearance, counter-sunk screws should be used, and a sheet-metal cover, spun or just flanged, slipped over each cylinder cover to hide the screw-heads. Plenty of big engines have sheet-metal caps over their cylinder covers.

Screws are Easily Made

However, any locomotive builder who has a few odd bits of steel in his scrap box need not worry about the shortage of commercially-made screws, nor pay exorbitant prices for the few that are available. Although I emulated the shopping tactics of a prudent housewife in pre-war days, and always purchased a little extra "in case of emergency," so that the present situation has not left me stranded, it occasionally happens that I need a few screws of a special kind; and these are always home-made on the spot. I might here mention, as a matter of interest to those whom it may concern, that the design for the "L.B.S.C. locomotive-builder's combination lathe" includes a built-in tailstock turret which enables the machine to produce screws, bolts, headed pins, handrail knobs and lots of other components, by the gross, without the slightest trouble.

No Special Tools

No special tools are required for the number of screws likely to be needed at the present time by the average locomotive builder. All I do is to put on my slide-rest turret which carries the necessary tools for steel or brass turning, as the case may be, and put on the tailstock die-holder with the required die in it. Hexagon rod is used for hexagon-head screws; ordinary round rod used for the ordinary cheese, round or countersunk heads. The three-jaw chuck on my small Boley lathe is true within a thousandth, and it is used to grip the rod; but even with a cheap lathe and a chuck that is slightly "out," there is no cause for alarm, as the head of the screw need not be absolutely dead true with the stem. It holds just as well if slightly eccentric, and Inspector Meticulous would need to put on a pair of X-ray glasses to detect any eccentricity when the screw is home. An ordinary knife tool is used to turn down the rod to the required diameter of the screw, and only the first one needs measuring, as the reading of the "mike" collar on the cross-slide handle is noted, and the slide brought to the same position for the rest of the batch. If your cross-slide handle has no "mike" collar, simply note the position of the handle itself.

Countersunk Screws

If countersunk screws are required, the second operation is to slew the turret around, to bring the chamfering tool to its "action station," and the shoulder chamfered off. The tailstock, with die holder attached, is then run up and the thread put on, after which the turret is slewed again, the parting tool presented to the rod, and the screw parted off. It sounds a lot to read about, and seems a long job to write about; but I could have made several screws whilst writing the above paragraph.

Finishing Off

Hexagon - headed screws merely need reversing in the chuck, and given a touch with the chamfering tool. Roundheads can be reversed in the chuck, and rounded off with a touch of a smooth file. Cheese, round, or countersunk-headed screws should be gripped between lead clams in the bench vice, and the slot for screwdriver put in with a small hacksaw, or an Eclipse 4 S tool, using the thinner slotting blade. Unless you are going in for "mass production," it isn't worth while setting up in a miller (that is, of course, if available !) or rigging up an attachment to machine-cut the slots. It amuses many people because I do lots of jobs by hand, when I have the means of machining available; but to misquote a former Prime Minister, "time isn't on my side," and Anno Domini is now compelling me to make the best use of the minutes. I can very often do a job by hand work in far less time than it would take to set up on a machine.

When turning blanks for steel screws use a knife tool with plenty of top rake, and take off just the extreme sharp point on an oilstone, merely enough to prevent the tool leaving a scratched surface on the blank. So long as the blank is the right diameter there is no need for a "posh" finish if the thread is to go right to the head; but in the case of little bolts, where part of the stem is plain, aim for as good a finish as you can get. A good supply of cutting oil helps the whole series of operations.

A Tip for the Novice

Tip to inexperienced lathe users: when turning blanks for 3/32-in. or sizes below, don't attempt to reduce the rod to finished size in one cut. This can only be done by a proper capstan tool in a knee-holder with a steady, which supports the rod directly behind the cut. If you attempt it on an unsupported rod, the result will be a triangular-section blank, tapering from the outer end to the shoulder. Take about three cuts, the last only removing a couple of thousandths or so, and you will get perfect blanks. A high speed is essential; my Boley lathe turns out perfect blanks when running at 1,350 revs. per minute, so if you do the job with a pedal-driven lathe, it will need the equivalent of "stepping on the gas."

Top Rake *is* Better !

Although no top rake is supposed to be required for brass turning, I find that a raked tool produces far better brass blanks than a flat-topped one. The same caution is needed to ensure that the blanks are circular and parallel, but no lubrication is, of course, necessary. Another tip is to be careful with the die, and keep it clear of chippings, whether brass or steel; if it becomes choked, and a chip jams the cut, away goes the screw blank before you can say "red pencil," and then it will probably provoke further mild annoyances when you waste half-an-hour or so in getting the broken bit out of the die ! However, if you pull the lathe belt with one hand when screwing blanks, and grip the die holder direct, or hold a small spanner on it with the other, you can usually "sense" if a calamity is about to occur, and take the necessary precautions to prevent it.

Makeshift Screw Material

Probably somebody will say, on reading the above, "Yes, all very fine, but where do we get steel or brass rod if we haven't any in stock?" Well, I doubt if there are any locomotive builders who are unable to rake up a few odd lengths of small diameter rod from their "oddments box"; quite small bits will do for screws, and if of too large a diameter for the heads, they can be turned down to size. You should have seen some of the stuff poor Curly used. "Poor" Curly he was, literally; not only then, but for many years after he lost his curls. Bits of iron and brass wire, French nails, brass and iron boot rivets, blanket pins and goodness knows what else, were all pressed into service. Curly had a discarded clockmaker's screwplate (I forget now how I came by it, but I still have it, after all these years, and it is still usable) which had no cutting edges to the holes, but formed threads by pressure; and the poor kid managed somehow to make screws with it. Not exactly precision finish, as you may guess; but they held, and cost nothing, so we were quite happy.

Years after, when Alexander's book, *Model Engine Construction*, came out, there were a couple of paragraphs in it dealing with screw making. The instructions said, take a piece of iron wire the size of the screwhead, grip in hand-vice, file it down to requisite diameter, grip the head end in the bench-vice, and put the thread on with a screwplate, not forgetting to oil the hole. If

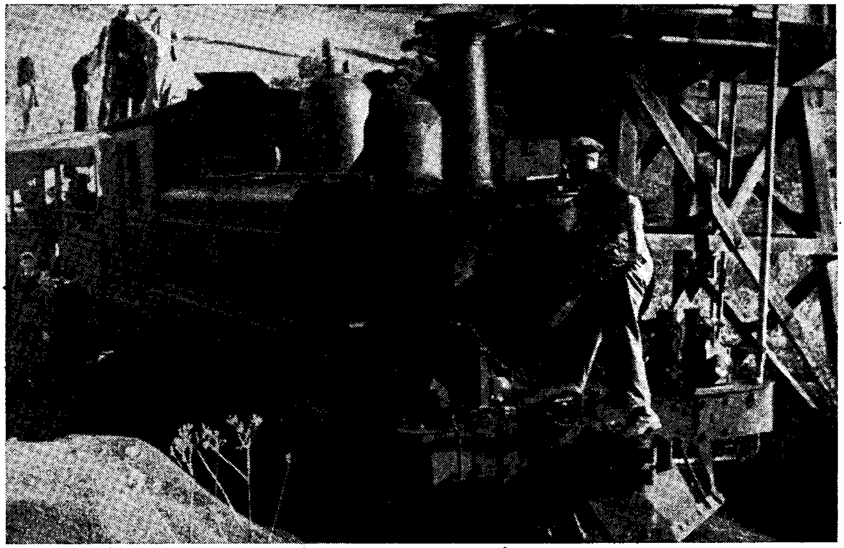


Photo by] **At the "half-way house."** [*R. Brown*

the screwplate went "hard," file down the blank a little more. The head end could then be filed square. Nuts were made by drilling and tapping a hole in a tiny square of sheet brass.

That was all right as far as it went, if you could file "round" and had sufficient time and energy. Mr. Alexander said he recommended screws made as above in preference to buying them ready-made, which isn't exactly the idea of present-day locomotive builders; but what always puzzled your humble servant was this: Friend Alexander kicked off in the very first paragraph of his book by saying that a lathe was indispensable, and couldn't be done without. Presuming his readers followed his recommendations and bought a 3½-in. bench lathe, why the merry dickens he didn't tell them to make their screw blanks on it, even if they only gripped them in the "wire" chuck and filed the shanks whilst revolving, instead of hand-filing them on the partly-opened jaws of the bench-vice, is something the remnants of Curly hasn't been able to fathom unto this very day. But to give our late friend his just due, his locomotives licked the most expensive of their commercial contemporaries of even date, for "going."

His valve settings were on the right lines, and he advocated a good blast for his "spirits-of-wine" fires so that his "works" didn't require overmuch steam, whilst the boilers made plenty. Alexander was certainly modest about the power of his engines, saying that they would "work fairly well and haul two coaches with good strong steam"—30 lb. was his maximum limit—but they could do far more than that. Their chief fault was the designer's craze for lightness of construction and the minimum of bearing surface. He cherished the erroneous idea that the less bearing surface you had, the less friction was set up; and so he specified frames of 20-gauge sheet brass with the axles running through plain holes drilled in them. The expansion links of his 4-4-0 were also of 20-gauge sheet brass, and the rest of the whole issue made to suit, so that the whole bag of tricks did not last the proverbial five minutes in service, which was a great pity.

Reverting to the screw question, it is safe to assert that whilst in normal circumstances it is hardly worth while bothering to make your own screws when supplies are plentiful and cheap, under present conditions anybody who spends a little time converting their odds and ends of scrap rod into screws as described above, can be entirely independent of the shortage of supplies, and will save money in the bargain.

Happy-go-Lucky Railroading!

Sergeant Rod Brown, writing from Sydney, N.S.W., sends the very interesting photos. reproduced here, of the way some narrow gauge lines are worked in Australia. Note the passengers sitting on top of the coach behind the engine, and imagine yourself doing likewise on the leading coach of the "Coronation Scot!" Our friend says the little locomotive does her job marvellously well, tackling the numerous banks with an exhaust crack like a G.W. "King"; but she gets plenty in the smokebox, which usually needs cleaning out during

the run, this job being shown in one of the pictures.

Lengthening Valve Travel

A reader has a locomotive fitted with Stephenson link motion, the crank axle being turned from the solid, and a very nice job at that ; but the unfortunate part about it is that it was designed and built according to the " ancient and fishlike " ideas about valve-gear, and in consequence the valves have very little movment even in full gear. Our worthy friend wants to modernise the valve-gear and bring it up to " Live Steam " specifications, but is in a bit of a dilemma, as he says he is unable to turn up a fresh crank axle on his small pedal-driven lathe,

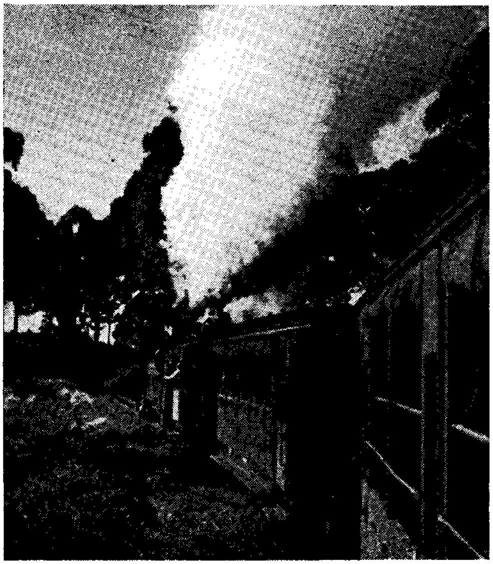


Photo by] [*R. Brown*

Climbing the bank on an Australian narrow-gauge line.

and therefore does not wish to scrap the existing one. Is there any means of lengthening the valve travel, and yet retaining the eccentrics as fitted ?

In this case, to use a political expression in reverse gear, the answer is in the positive. The engine has the ordinary locomotive-type links, with the eccentric rods connected above and below the slot, so that the die block in full-gear position travels less than the movement of the eccentric rods, being nearer to the middle of the link. If the die blocks could be made to travel the same amount as the eccentric rods, the trick would be done ; and this can be accomplished by doing away with the existing links and replacing them by a pair of launch links as used on Great Western engines. The radius of the slots in the new links should be the same as those on the existing links ; but the slots should be a little longer, say, extra by the length of the die block. The eccentric rods will need to be shortened by an amount equal to the distance from the centre of the slot to the centre of the pinhole in the lug for attaching the forks of the eccentric rods. My correspondent doesn't say how the rods are attached to the straps ; but if it is not possible to cut them at the strap and make fresh connections after shortening the rods, the latter could have a piece taken out anywhere in their length and joined afresh by brazing with brass wire, or Sifbronzing if an oxy-acetylene blowpipe is available. The rods should be re-joined on a jig, as described for " Molly " and other engines, in order to make certain that the four rods are all exactly the same length.

An Alternative

New valves will be required, with longer laps to suit the lengthened valve travel ; alternatively, the same valves could be utilised if little pieces are silversoldered to the ends and trimmed off square, the valves afterwards being carefully refaced by the methods described in past notes. The setting should be exactly as I always recommend, viz. : a crack of lead showing the edge of the steam port when the crank is on corresponding dead centre. The lengthened travel and consequent increase in the speed at which the ports open and close will make the engine ever so much livelier than she was before, whilst there will be a very noticeable difference in the sharpness of the exhaust. It will probably be found desirable to open out the blast nozzle a little, which should be done if the boiler persists in blowing off all the time the engine is running.

The above method of lengthening valve travel by substituting launch-type links for the ordinary locomotive-type was adopted by the late Sir H. N. Gresley when rebuilding the " 1500 " class engines of the old Great Eastern Railway. These engines, as originally designed, had ordinary valves on top of the cylinders, driven by Stephenson link motion with locomotive links and rocking shafts. The valves were replaced by long-travel valves, and the locomotive links by longer launch links, the result being that whereas before conversion they would only notch up to about 30 per cent. cut-off, afterwards they would notch up to 17 per cent. or even less, and still maintain the same power and speed, whilst the coal consumption dropped in proportion to the lesser quantity of steam used. Our friend can count on similar results when he converts his little engine in similar manner.

Backhead Steam and Water Fittings

for Small Locomotives

By S. LEES

MANY model engineers have a conscientious desire to make all their detail parts and fittings. This feeling is laudable and understandable, since the builder of, for example, a fine scale locomotive may get a twinge of remorse when he looks over his handiwork in private, maybe with pardonable pride, and is reminded that such and such a fitting was bought "over the counter." The usual reaction to this feeling is to substitute fittings of his own make forthwith. Boiler backhead fittings come within this class, and the making up of such small fittings is a really interesting class of work.

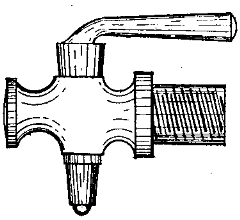


Fig. 1. Simple blow-off or try-cock.

The writer believes that any disinclination to tackle tiny brass-finishing jobs is completely dissipated if all the fittings for a given model be planned beforehand and tackled in bulk or unit form, just as other sections of a built-up machine are dealt with. Further, there is an absence of mass production boredom about the making of small steam and water fittings, since there is such a variety of form that offers wide scope for new and unconventional ideas. And so the work then takes on an altogether unexpected interest and provides the builder with more latitude for devising details of design impracticable with commercial fittings, and, moreover, gives the model in hand a completeness, uniformity, finish and harmony of tone too often lacking in otherwise well-built models.

Lathe and Vice Jobs

Water-gauges, plug taps or cocks, and the various types of plain straight-through or screw-down valves all come within this class. These fittings are not difficult to make, being stereotyped lathe and vice jobs, and so well within the capacity of the average model engineer who is conversant with his lathe. Material, too, does not present such an acute problem as other jobs, as such fittings are usually made from stock bar or castings, or, in fact, from scrap. The writer has turned out really useful fittings made of discarded safety razor (metal) handles.

There is, it is admitted, an aspect about home-made fittings that may perhaps have discouraged many enthusiastic modellers, and that is a difficulty they may have experienced in producing sound steam and water-tight plug cocks. The conventional form is far from perfect in design and does

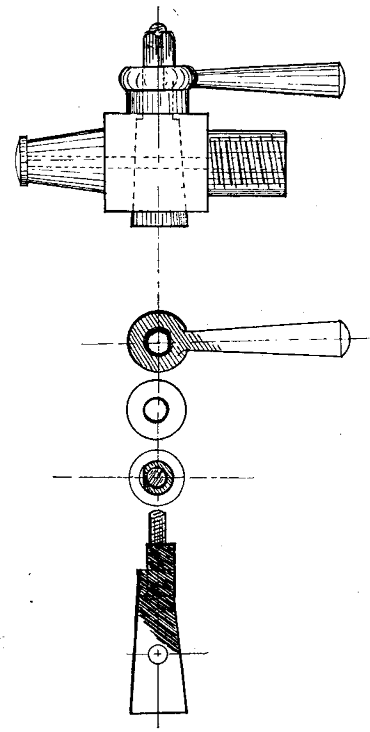
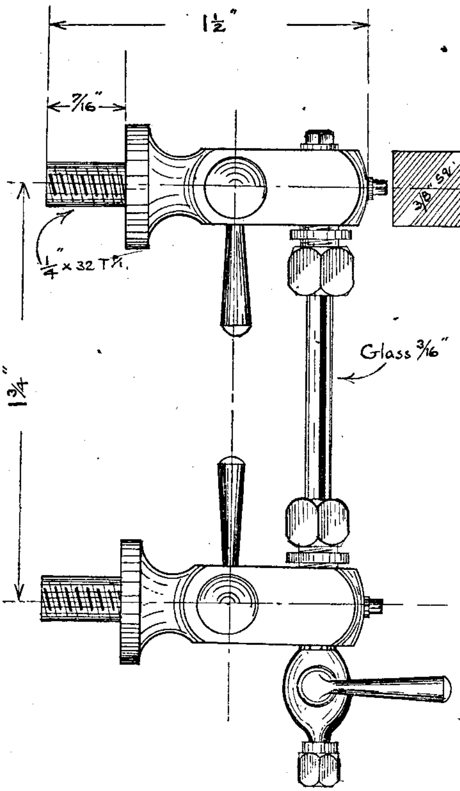
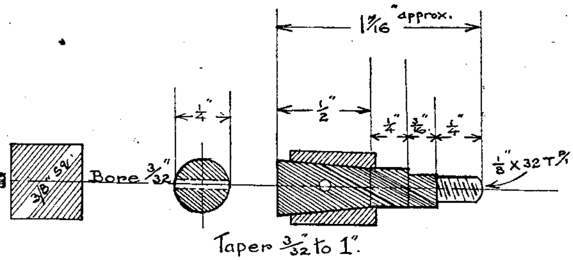


Fig. 2. Modified multi-purpose cock.

not lend itself to rough handling. When it becomes leaky it is usually scrapped, since it is not adaptable for re-seating.

With a view to assisting other model engineers the writer would (modestly) like to suggest another type of plug-cock not so widely known as it deserves to be, which





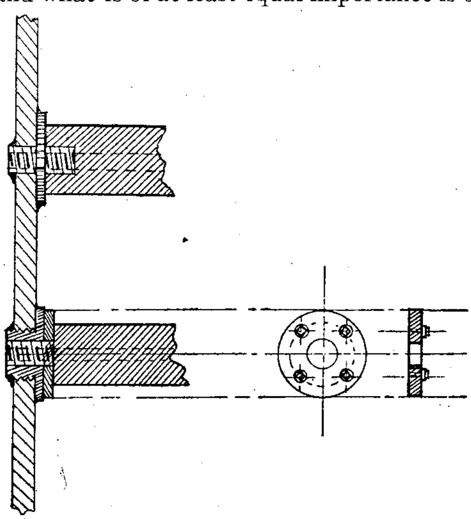
Figs. 3 and 4. Modified three-cock water-gauge.

has advantages over the orthodox standard type, drawn at Fig. 1. The cheap cocks of this class have plugs simply burred over or expanded by a centre tool, the more expensive kind being fitted with a long threaded tight nut. It is pretty safe to say that these cocks do not lend themselves readily for repairs and often break on being taken apart. Unless used frequently the plugs tend to stick or "seize," and the bent handles snap off at the reduced angle of the bend.

On reference to Fig. 2, a modified type of plug-cock is shown which provides for adjustment and reseating due to wear, and further, what is all important, is really steam/water tight if properly made and fitted. The cock plug is fitted in reverse compared with the standard type, and it is important that the correct angle be used, and that both the cock plug and bore exactly coincide and bear evenly throughout. All cocks should be lightly lapped to a tight smooth fit by grinding with fine abrasive not coarser than crocus or finer jeweller's powder. The important features of this form are the reverse plug, the degree of taper, and the simple lock to prevent relative movement between the plug and the handle.

For material the writer uses phosphor-bronze for the gauge, cock, or valve block and "best" brass bar for the plug. But in this direction there is ample scope for experimenting by the model engineer in the selection of dissimilar metals to prevent scoring and "seizure." The writer has used the expression "best brass bar" since it is in common usage, but it is well to accept most of the trade terms with appropriate reserve in defining the properties of such non-ferrous metals.

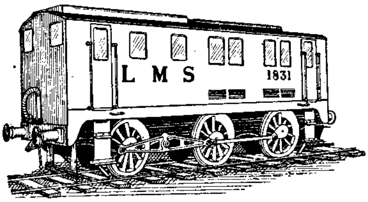
For a given fitting the dimensions obviously will depend on the size of locomotive. For example, on a 4½ in. gauge loco., the writer works to the dimensions shown at Fig. 3 and Fig. 4. This three-cock water-gauge harmonises with the cab and backhead, and what is of at least equal importance is of



Figs. 5 and 6. Alternative water-gauge mountings for backhead.

real utility. Like their prototypes, gauges, valves, cocks, and all fittings with internal working parts should be regularly taken apart for inspection and cleaned, and adjusted and overhauled periodically. Gauge glass protectors are rarely used except on show-case models.

(*Continued on page* 431)



★ EDGAR T. WESTBURY'S

1831.

Adjustment of the Carburettor

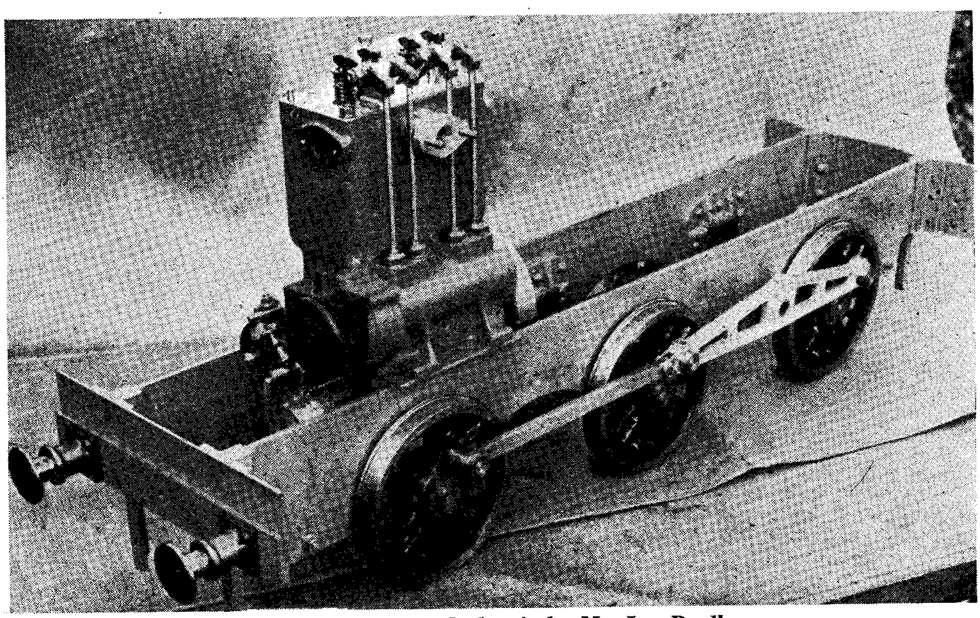
WHEN the carburettor is first fitted to the engine, the initial adjustment is facilitated if arrangements are made for motoring the latter under a separate source of power. One hears quite a lot about brand new engines starting up at the first pull over, but while it is not denied that such happy phenomena do occur, it is not the sort of thing one can count on, even with the best engines and the best carburettors. There are innumerable little details which may prevent an engine running under its own power, especially when all adjustments are a totally unknown quantity. A discreet silence is usually preserved about the engines which refuse to start up in such exemplary fashion, but I hazard the guess that they are very much in the majority, and for this reason I always recommend motoring them off in the initial tests, if only to save strains on the muscles—and the patience!

Direct-coupling to an electric motor is the most convenient method of motoring the engine, but belt coupling is also quite satisfactory. If a drive is taken from a heavy lineshaft, however, some means of slipping or disconnecting the drive is necessary, to allow the engine to overrun the speed of the drive. A freewheel pulley is the most convenient device for this purpose.

The engine should be adjusted to run at a comparatively small throttle opening at first, so that it cannot race away at a dangerous speed. All adjustments, including the ignition timing, should be manipulated so that the best possible results at this setting are obtained, and the engine allowed to run for some time so as to settle down to working conditions. The response to throttle control should then be tested, and any variation of mixture strength at various openings carefully noted.

For those who are quite uninitiated in model petrol engine running, it may be mentioned that the usual symptoms of incorrect mixture are as follows: *Rich mixture*: heavy and sluggish running, with emission of *black* smoke from the exhaust (not blue or light-coloured smoke, which is caused by excess of lubricating oil); in

* *Continued from page* 368, "*M.E.*," *April* 16, 1942.


"1831" engine and chassis by Mr. Ian Bradley.

extreme cases, the engine will surge (alternately speed up and slow down) or misfire on alternate firing strokes (usually known as "eight-stroking"). *Weak mixture*: Engine may run very fast, but with little power, and recovery after it has been slowed down by load, or through misfiring, is very poor. There is a tendency toward violent spitting back into the carburettor; to race up and then peter right out; and rough running, with complete lack of flexibility to adapt itself to load conditions. Blue flame may be seen at exhaust ports, and the engine runs excessively hot.

The carburettor, when correctly adjusted, should enable the engine to run at any throttle position without exhibiting any of the above symptoms, the jet screw being set at one position throughout, and the primary air shutter wide open. As the throttle opening is increased, acceleration should be prompt, certain and smooth; and a sudden open-up or shut-down should be taken without stopping or seriously disturbing the even running of the engine. When closed down against the slow-running stop, the engine should run quietly, and without the least fuss, at a speed well below its working speed.

In order to verify conclusions regarding the mixture strength at various speeds, the main jet may be experimentally re-set to suit various throttle positions. If it is found necessary to close it down as the throttle is opened, it is clear that the extra air valve is not admitting sufficient air; and if it needs to be opened in these circumstances, the valve is working too freely. A "flat spot," or weakening of the mixture at an intermediate throttle position, indicates that the initial opening of the valve is excessive, even though the adjustment may be about correct for full throttle; in which case, lengthening the valve spring will effect a remedy.

General instructions on the action of the extra air valve, and its adjustment, have already been given. It should not be necessary to make any alteration in the size of the valve ports from those specified, unless the engine on which the carburettor is used is of a different size or type to that for which it is designed. The air passage through the primary choke should also be adequate for the requirements in view; it may be noted that most amateurs are inclined to make the primary choke tube of a carburettor far too large, with the result that low-speed compensation becomes impossible, and the engine will only run reasonably well when nearly flat out.

It should be clearly understood that the *final* adjustment of the carburettor can only be carried out when the engine is loaded up to produce the equivalent of working conditions. If adjusted when running light, the mixture will be found too weak when load is applied, especially during acceleration.

Some slight adjustment of ignition timing to suit engine speed will be found desirable, but in most cases, a fixed position of about 30 deg. advance will be found more or less satisfactory for the entire working range of speed, so long as the ignition is retarded for starting or prolonged idling.

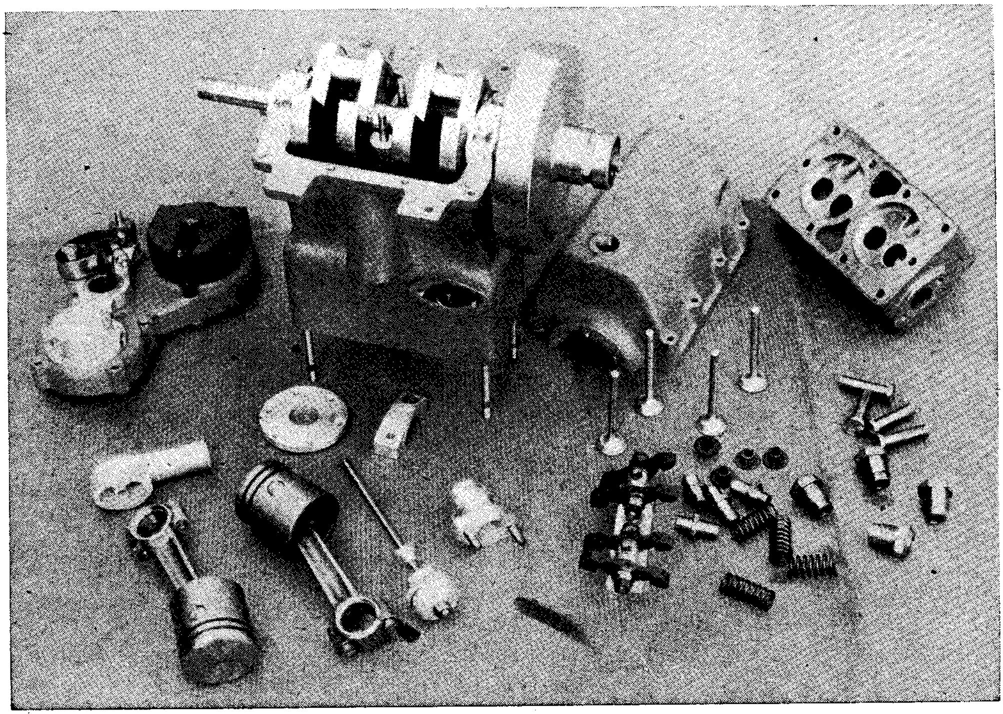
Starting

Excessive flooding of a carburettor is neither necessary or desirable, and in these days of petrol rationing, the waste which it entails is positively criminal. A momentary depression of the float needle, to make quite sure that the fuel is up to normal level and is flowing freely to the float chamber, should be quite sufficient. The primary air shutter enables the mixture to be enriched temporarily to assist starting; when closed, the only passage for the entry of air to the choke tube is by way of the sawcut in the shutter. Readjustment of the main jet to assist starting is undesirable, and generally quite unnecessary. When the engine starts, the air shutter should be opened *gradually* as it warms up, and finally left fully open throughout the running period. Re-starting while the engine is warm can usually be effected without closing the shutter.

Photographs of "1831" Components

I trust that no apology is necessary for the fact that practically all the photographs of finished or partly-constructed components of this model, which have so far been published, have emanated from a single source. It happens that, while I have had more or less definite news, from time to time, of several examples of "1831" which are under construction, the only one with which I have been able to keep in close touch is that being built by Mr. Ian Bradley. Most readers will, however, agree that the parts of this model which have been illustrated, are well worthy to be displayed as representative examples of what can be done with the design and the available materials.

I do not propose to eulogise Mr. Bradley's work, however, neither is it necessary, as the photographs speak for themselves, even though they cannot convey an adequate impression of the fine workmanship he has put into these components. Any other readers who are in a position to furnish similar evidence of progress on this model are equally entitled to a measure of publicity, and I would welcome any news which may be forthcoming on the subject. It is fully understood that some readers may not be able to supply photographs under present



The components of the engine for "1831."

conditions, but it is probable that I may be able to help them out in this matter if they will acquaint me of their difficulties.

There are few things more encouraging to actual or potential constructors of a model than visible evidence of what others have achieved, and I trust that readers will do their best to assist me in producing it in variety and abundance..

(*To be continued*)

Steam and Water Fittings

(*Continued from page* 428)

It may, perhaps, be remarked that fully dimensioned details are not shown. This for the reason before mentioned that thereby the builder has unlimited scope to exercise his own fancy or ingenuity in deciding on a definite design. Often it may occur during a job that an idea flashes through the mind for modifying or improving details with advantage. For example, there are obviously various alternative methods of attaching a water-gauge to its backhead. A loose nipple, as shown at Fig. 5, facilitates dismantling the gauge for overhaul. Or the flanges may be dispensed with, and again should sheer realism be a desideratum, a dummy flange, complete with bolt heads or nuts, Fig. 6, gives a real touch. Needless to say, boiler fittings such as described should never be trusted to hold direct on a thin backhead; some form of threaded bush, flange, or stool should always be used and such foundation fittings preferably attached during construction of the boiler.

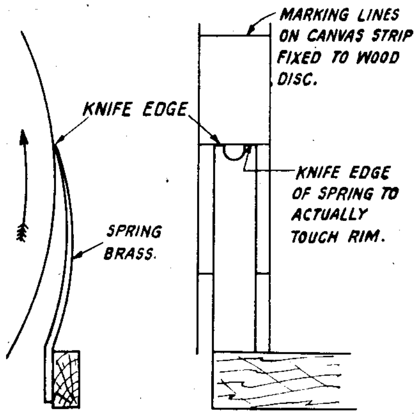
It is strange how quiet contemplation of a piece of handiwork in progress will often suggest—nay, almost inspire, us to modify original plans and sometimes discard altogether the results of many valuable hours of labour by sheer scrapping and starting afresh. Therein lies, if not the secret, then the indefinable charm and real educative value of all craftsmanship; ever the urge to do better is the aim of the enthusiastic craftsman.

Letters

Making a Division-Plate

DEAR SIR,—Further to my solution as published, I have made another division-plate, using the revised method of registering, as per sketch herewith.

This new plate has an average error of only 0.0023 in. and is, I believe, as accurate



as would be made on an average dividing-head in an average factory.

I realise, of course, that much greater accuracy would be obtained if a proper jig-boring machine were employed.

You will be interested to know that a recent meeting of the Norwich Society was devoted entirely to a discussion on this question. Practically all the members present were content with the geometric or trigonometrical statement of how to set out the divisions. A very few had any idea of how this accurate marking-out was to be transferred to the actual drilling.

The problem I believe was how *to make*, not to know how *to set out* a plate.

Yours truly,

Norwich. H. O. CLARK.

Clubs

The Society of Model and Experimental Engineers

There was a full attendance at the Ordinary Meeting held at The Caxton Hall, Westminster, on Saturday, 11th April. Mr. C. L. Clarke, South Lambeth, Mr. R. M. Evans, Great Missenden, and Mr. David Hawes, London, N.W.1, were elected to membership. A silver medal was presented to Mr. F. D. Bolding, for work exhibited at the Annual General Meeting, and certificates of merit were awarded to Lieut. F. C. Snewin and Mr. J. Taylor. On the conclusion of the formal business Mr. J. R. Clark gave a lecture on "Railway Photography," which was illustrated by lantern slides, while a twin lens reflex camera, built by the lecturer, was passed round for inspection.

Secretary, H. V. STEELE, 14, Ross Road, London, S.E.25.

Birmingham Society of Model Engineers

Our Easter Re-Union was indeed a "pleasurable" occasion, and about 60 members and wives attended. In addition there were about 20 visitors, not among the least being a young man who had cycled all the way from Rugby. Six locos. were run, and on the "show stand" were Mr. Finch's "Rainhill," nearly finished, and another "Rainhill" chassis. Three fine petrol engines were also set going on the bench several times during the day.

It was decided to recommence the meetings at the White Horse, Congreve Street, Birmingham, at 7.30 p.m. The first two dates are Thursday, 30th April, and Friday, 15th May.

Hon. Sec., W. H. KESTERTON, 31, Wood Green Road, Quinton, Birmingham

The Kent Model Engineering Society

May 3rd, track run, when it is hoped to have further extensions to present length of available track in operation.

The Secretary will be pleased to forward particulars of the Society.

Hon. Secretary, W. R. COOK, 103, Engleheart Road, Catford, S.E.6.

The City of Bradford Model Engineers' Society

Sunday, May 17th, Channing Hall, at 10.30 a.m., Mr. A. Chubb will give another of his interesting lectures, the subject being "Timekeepers, Ancient and Modern."

Hon. Sec., G. C. ROGERS, 8, Wheatlands Grove, Daisy Hill, Bradford.

York and District Society of Model Engineers

Next meeting will be held on Friday, May 1st, at 7.30 p.m., at the address below. Track night if fine.

H. P. JACKSON, Hon. Sec. *pro tem.* 26, Longfield Terrace, York.

NOTICES.

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects. Matter intended for publication should be clearly written, and should invariably bear the sender's name and address.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

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